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AVIATOR'S NIGHT VISION IMAGING SYSTEM PREFLIGHT ADJUSTMENT/ASSESSMENT PROCEDURES

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Night vision goggles (NVGs) have been employed in a variety of aircraft for over 20 years. However, only recently has their application begun in fixed-wing fast movers. Research accomplished by the Aircrew Training Research Division of the USAF Armstrong Laboratory demonstrated the loss of NVG performance resulting from improper adjustments. This report describes correct adjustment procedures for the Aviator's Night Vision Imaging System, or ANVIS. The procedures described were developed so aircrews could take advantage of the adjustments available on the NVGs. Additionally, image descriptions are given to help aircrews evaluate NVG performance. Information on the proper equipment/space needed for proper evaluation is also included.			
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PREFACE

This work was conducted at the Armstrong Laboratory, Aircrew Training Research Division (AL/HRA) in Mesa, Arizona, by AL/HRA and the University of Dayton Research Institute (UDRI). Among many other research efforts, AL/HRA conducts visual training effectiveness research in support of aircrew training technology. One entity of this effort is the night vision training research program.

UDRI, working under Contract F33615-90-C-0005, is developing prototype instructional media and courseware to be used in aircrew night vision goggle (NVG) training. This report contains adjustment procedures for the ANVIS NVG designed to maximize aircrew visual performance. The laboratory contract monitor was Ms Patricia A. Spears for the work performed under Work Unit 1123-03-85, Flying Training Research Support, and 1123-32-06, Night Vision Device Training R&D for the in-house portion of the effort. The laboratory task order monitor was Dr Elizabeth L. Martin.

The authors would like to thank Ms M.E. McConnon and Ms D.L. Bolin, UDRI, for their creative abilities in assembling this report.

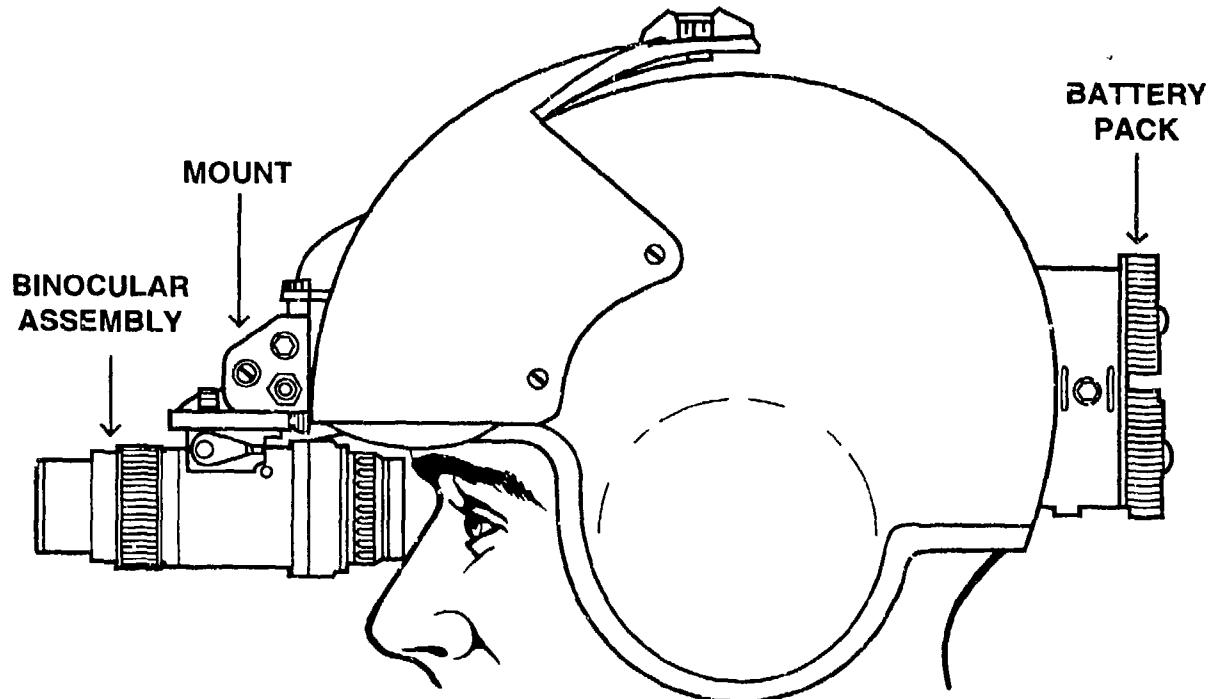
AVIATOR'S NIGHT VISION IMAGING SYSTEM PREFLIGHT ADJUSTMENT/ASSESSMENT PROCEDURES

INTRODUCTION

Night vision goggles (NVGs) have become an integral part of night operations in many aircraft. With proper fit and adjustment, they dramatically enhance night vision. However, improper adjustment can severely degrade visual acuity. While NVGs are not difficult to use, proper adjustment procedures are essential to maximum performance. This report presents the basic preflight adjustment and assessment procedures for the Aviator's Night Vision Imaging System (ANVIS).

NVG COMPONENTS

ANVIS NVGs consist of three components: (a) the mount assembly, (b) the battery pack and (c) the binocular assembly (Fig. 1).



*Figure 1
ANVIS Components*

Mount Assembly

The mount assembly (Fig. 2) is secured to the helmet and holds the binocular assembly in position. The mount assembly is available in several configurations and the one used is determined by helmet type, aircraft type, and mission. Although the several configurations differ in some respects, all have a common interface with the binocular assembly.

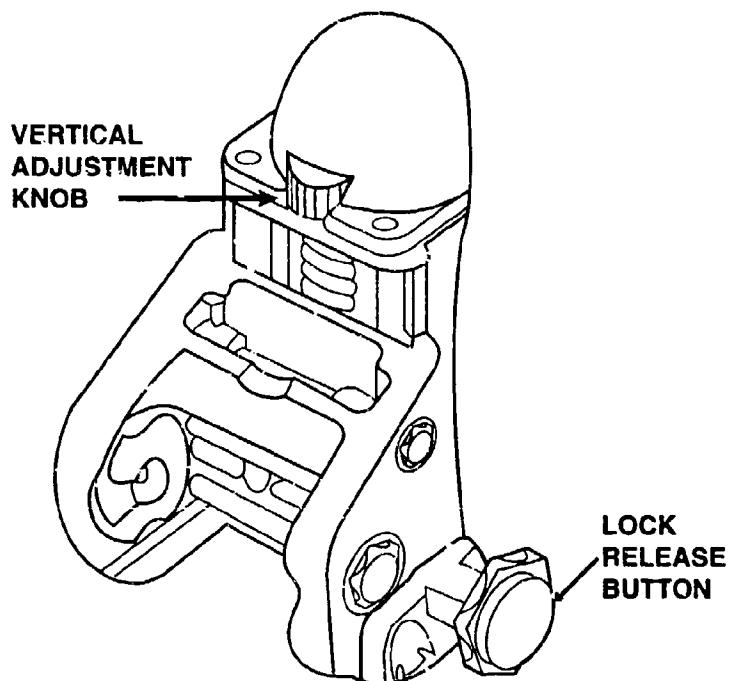


Figure 2
ANVIS Mount Assembly

Vertical Adjustment Knob. Moves the binocular assembly up and down.

Lock Release Button. Releases the binocular assembly to permit rotation from the stowed position to the operating position, and vice versa. The lock release button should always be employed when changing the position of the binocular assembly. Otherwise, excessive wear of the latching mechanism will occur and the goggle will not latch securely in the stowed position. It also may bounce up and down in the operating position during abrupt head movements or turbulence.

Low Battery Indicator. A small red light emitting diode (LED) provides warning of impending battery failure (Fig. 3).

**Low Battery Indicator on Bottom of Mount
Small Red LED**

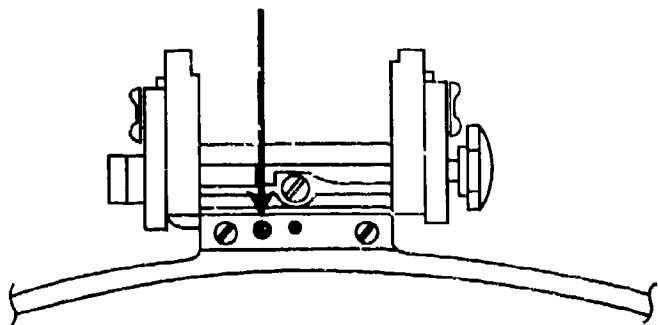


Figure 3
Low Battery Indicator

Battery Pack

The battery pack (Fig. 4) provides power to the NVG. The battery pack is typically mounted with velcro on the back of the helmet. There are two different battery pack configurations, one which accepts only the lithium cell ("short" battery pack) and another which permits the use of either lithium batteries or AA alkaline cells ("long" battery pack).

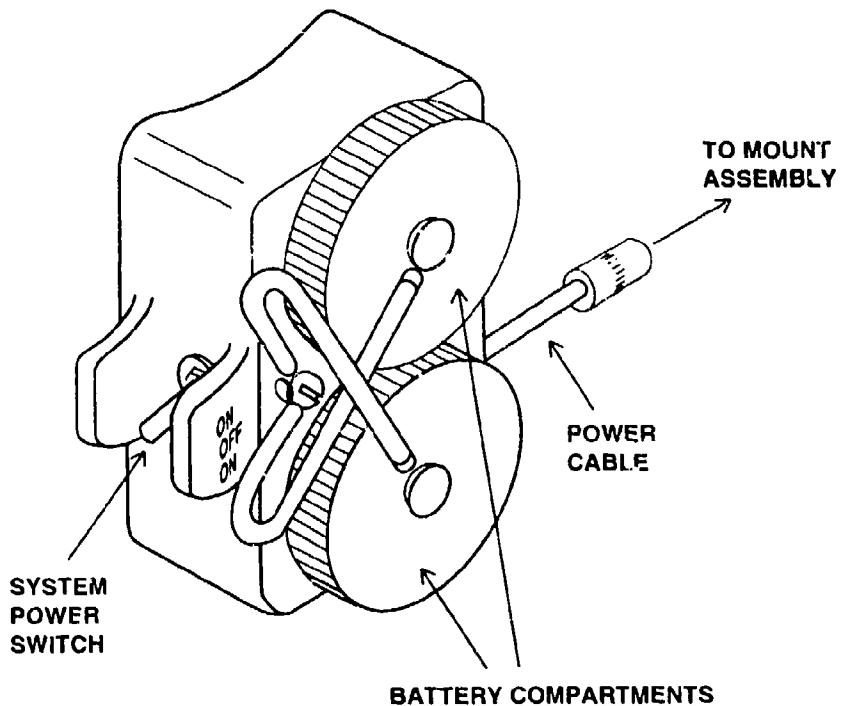


Figure 4
ANVIS "Short" Battery Pack

On/Off Switch. A three-position switch is located on the side of the battery pack. The goggle is operated by either battery compartment individually, as determined by the position of the switch. This provides an internal spare within the system.

Another method of turning the NVG off is by rotating the binocular assembly from the operational position to the stowed position. However, if using this means to turn the NVG off, the main power switch remains on and the NVG can inadvertently be turned on in the presence of bright lights (such as found in life support) when the binocular assembly is rotated back to the operational position. Be sure to turn the main power switch off, regardless of the binocular position, once the NVG will no longer be used.

Battery Compartments. The lithium batteries are inserted negative side up. The negative end of these lithium batteries is the end with the pole. The AA batteries are placed side by side in a battery pack which is inserted into the battery compartment with the poles down (Fig. 5). Check the diagram on the side of the battery pack to ensure proper battery installation.

Power Cable. The power cable connects the battery pack to the mount assembly which in turn provides power to the NVGs. There are red dots on the power cord connector and the mount assembly connector to facilitate connection. Align the dots and gently press the connectors together. Do not force or twist the cable as damage may occur to the small pins in the housing.

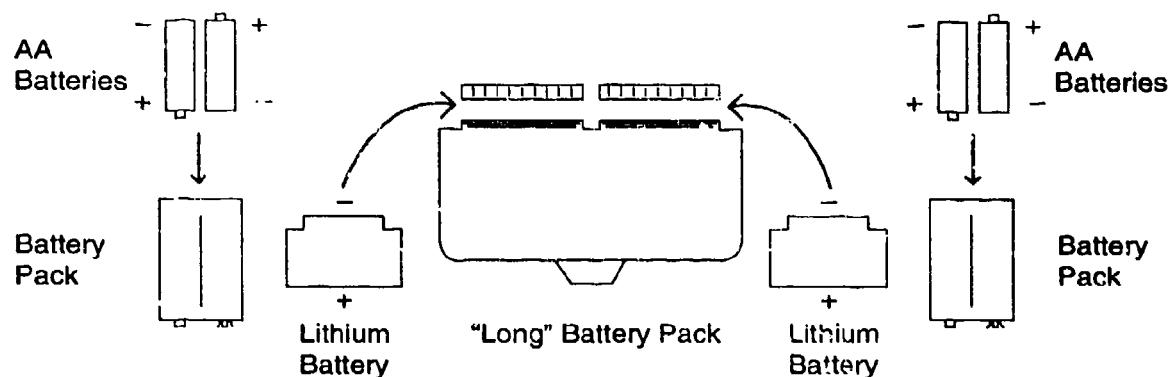


Figure 5
Battery Installation

Binocular Assembly

The binocular assembly (Fig. 6) consists of a pair of monocular assemblies which incorporate the optical elements and the remaining adjustment controls.

Eye Relief Adjustment. Moves the entire binocular assembly toward or away from the eyes.

Tilt Adjustment. Tilts the binocular assembly to align the optical axes of the monocular assemblies with the visual axes of the eyes.

Interpupillary Distance (IPD) Adjustment. Moves the monocular assemblies to match the distance between the eyes.

Objective Focus Ring. Focuses the goggles for distance.

Diopter Focus Ring. Focuses the image on the retina of the eye.

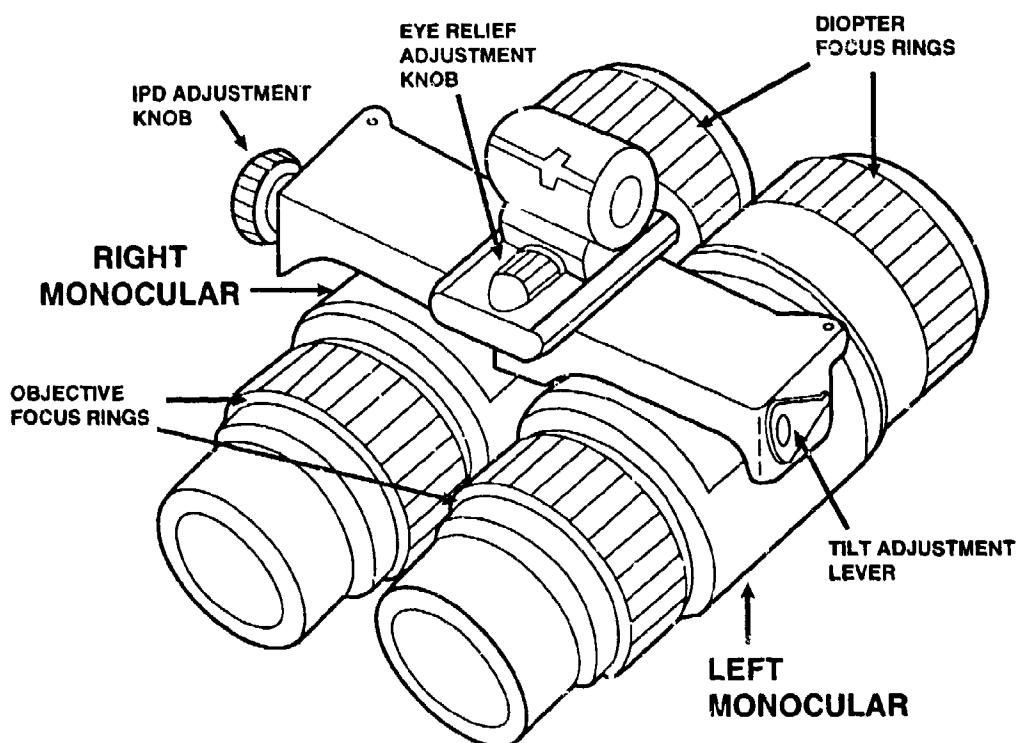


Figure 6
ANVIS Binocular Assembly

ADJUSTMENT AND ASSESSMENT PROCEDURES

Adjustment procedures should be performed in a 20-foot eye lane using a USAF NVG Resolution Chart illuminated by an appropriate source. It is recommended that the high contrast chart be used. See the SUPPORT ISSUES section for details on how to acquire a resolution chart and how to construct an illumination source for the eye lane.

The purpose of using the NVG eye lane is two-fold. First, it provides a place to adjust the NVGs. Second, it permits a check of the performance of the device. The preflight adjustment/assessment procedures are divided into five parts: (a) inspection and initial adjustment, (b) goggle alignment, (c) focusing, (d) assessment of function, and (e) cockpit procedures.

Inspection and Initial Adjustment

Perform the following procedures prior to donning the helmet/NVGs.

Inspect Helmet. Perform the usual preflight inspection of the helmet and helmet components.

Inspect Mount Assembly. Ensure that the mount assembly is correctly positioned and firmly attached to the helmet. An improperly positioned mount assembly may make it impossible to achieve proper positioning (alignment) of the goggle.

Inspect Battery Pack. Check for damage, loose parts, and frayed wiring.

Load Battery Compartment. Ensure that the switch is in the off position. Insert the batteries. If spare batteries are carried, they should be individually placed in a small resealable plastic bag or protected with some type of nonconductive material.

WARNING

To avoid venting or explosion DO NOT recharge, short circuit, puncture, mutilate, or expose lithium batteries to temperatures higher than 180 degrees F. The terminals should not be exposed to water, corrosive compounds, or conductive materials (loose change or car keys).

If the battery compartment becomes hot to the touch, turn the goggle off immediately. Allow the batteries to cool for at least one hour before removing them.

Attach Battery Pack. Attach the battery pack to the rear of the helmet. Typically, velcro tape is used to hold the battery pack in place. Connect the power cable to the mount assembly. It is a good idea to secure the cable to the helmet with tape. This helps prevent snagging the cable on protruding objects in the cockpit.

Inspect Binocular Assembly. Check the overall condition and security of the individual monocular assemblies. Make certain that all adjustments function properly and components move freely and smoothly. Check for loose parts or broken wiring.

Inspect Lenses. Inspect the lenses for cleanliness and scratches. Clean them if any soiling is present. Dust or particulate matter should be removed with compressed air or a soft brush. Do not wipe the lenses with anything other than lens paper or a lens cleaning cloth specifically manufactured for the purpose. If the NVGs are equipped with laser protective lenses, ensure that the inside surfaces of the lenses are clean. Dust particles or other material can get trapped between the objective lens and the laser protection lens.

Set Diopter. Set the diopter focus ring on each monocular at zero.

Adjust Eye Relief. Position the binocular assembly at its most forward position (away from the eyes) unless the correct setting is known, in which case it can be preset. However, it is important that the binocular assembly be adjusted far enough forward so that it does not contact the face, spectacles, or other personal equipment when the goggle is first donned and rotated down to the operating position.

Center Tilt. Set the tilt lever at its centered position.

Set IPD. Ensure the IPD adjustment operates smoothly. For the ANVIS system, both monoculars move simultaneously when the IPD adjustment knob is rotated. Check to make sure each monocular travels evenly and does not ratchet back and forth during movement. There is an IPD scale on the front of the binocular assembly (Fig. 7) which can be used to preset the IPD setting if it is known. Though the scale may not be perfectly accurate, it provides a good starting point from which the IPD can be fine tuned once the NVGs are mounted in place and turned on.

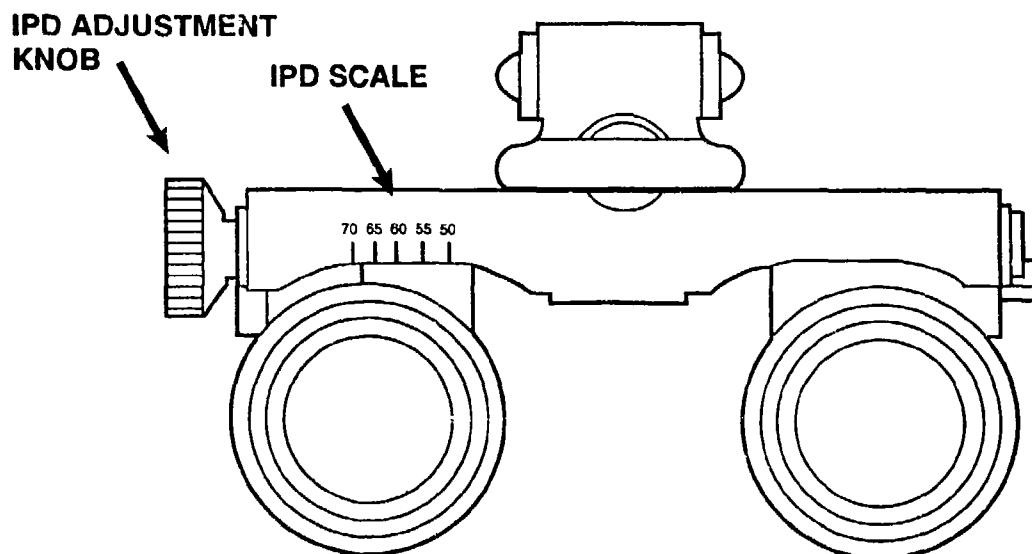


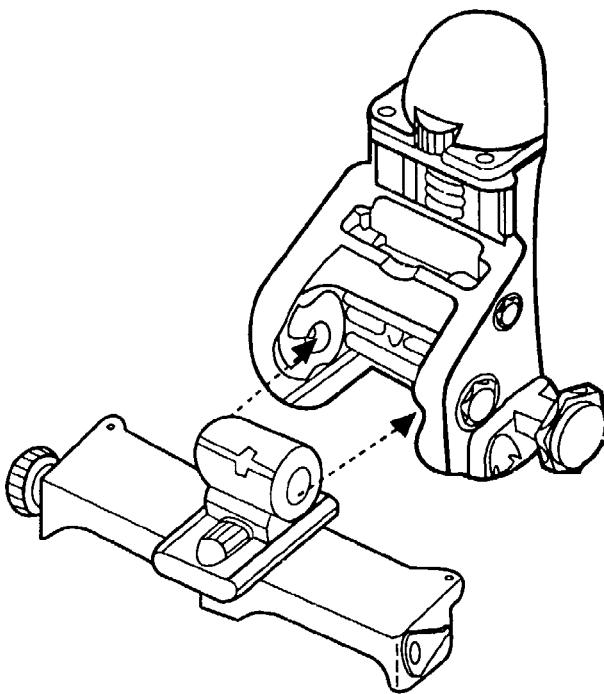
Figure 7
ANVIS IPD Scale

Adjust Vertical. Ensure that the vertical adjustment moves smoothly and tracks evenly up and down the mount assembly.

Don Helmet. Don the helmet. Fasten and adjust the chin strap. If an oxygen mask is worn, it should be attached and adjusted as it would be for flight.

Attach and Remove Binocular Assembly.

Align the spring loaded bearings of the binocular assembly with the grooves in the mount (Fig. 8) and push gently until the assembly snaps into place. Do not use excessive force. If too much force is required, it is an indication that the bearings are not properly aligned and the goggle may fail to seat properly or become jammed in the mount. The goggle will latch in the stowed position only if it is mounted correctly. Occasionally, the binocular assembly will seem to "snap into place" only to fall when released. Latching in the stowed position not only confirms that the binocular assembly is securely seated in the mount, it also indicates that the goggle has not been mounted backwards.



*Figure 8
Mounting the Binocular Assembly*

CAUTION

Do not release the binocular assembly before confirming that it will lock securely in the stowed position.

If a cord is attached to the binocular assembly, place it around the neck prior to attaching the assembly. This will keep the assembly from falling and being damaged should it become dislodged from the mount for any reason. When storing the NVGs do not wrap the cord around the housing between the monoculars.

Remove the binocular assembly by unlatching the goggle and turning the binocular assembly to a vertical position. Pull the binocular assembly straight forward out of the mount, preferably using both hands. If only one hand is free, the goggle can be detached by pulling forward on one side.

The binocular assembly should be in a vertical position during removal so that the force exerted to pull it from the mount is approximately perpendicular to its longitudinal axis. This will help prevent damage to the mounts of the individual monocular assemblies and preclude inadvertent changes to the eye relief adjustment.

Practice mounting and removing the goggle until comfortable with the procedures.

Alignment Procedures

Proper alignment is important because best visual performance is possible ONLY when the optical axis of the device is perfectly aligned with the visual axis of the eye (Fig. 9). For this reason, precise focus is not possible until proper alignment has been accomplished.

Once in the eye lane with helmet and NVGs donned, turn the lights off and turn on the NVGs.

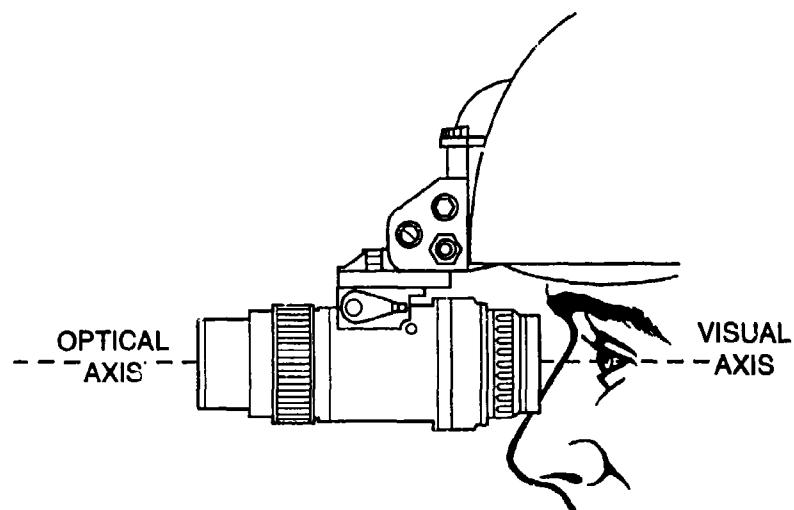


Figure 9
Alignment of Visual and Optical Axes

CAUTION

Do not turn on NVGs in a well-lighted area.
Repeated exposure to bright light will result in a
reduction in the life of the intensification tubes.

Vertical Adjustment. Adjust the vertical position of the binocular assembly using the vertical adjustment knob. The binocular assembly should be located directly in front of the eyes.

Tilt Alignment. Adjust the tilt so that the optical axis of the binocular assembly is perfectly aligned with the visual axis of the eye. Changes in tilt usually require a correction in the vertical adjustment, and vice versa.

Eye Relief Adjustment. If necessary, move the binocular assembly aft (toward the face) using the eye relief knob. Ideally, the NVG should be adjusted to maximize the NVG field of view without unnecessarily reducing the ability to see around the NVG to view cockpit displays or perform other tasks. It is especially important that the goggle **never** be positioned so close to the face that the eyepiece lens contacts spectacles or eyelashes.

IPD Adjustment. Confirm that the IPD is correct. If properly set, the two images will overlap to form a single image.

Evaluate Image. When the goggles are correctly aligned, there should be no shading of any part of the image. If shading is present, attempt to eliminate it by making adjustments in the direction of the shading. If there is insufficient travel in the goggle adjustments, move the entire helmet in the direction of the shading. If proper alignment can only be accomplished by moving the helmet, it is an indication that the mount assembly is not properly positioned on the helmet. Notify life support personnel so that the problem can be corrected.

Focusing Procedures

Move to a point 20 feet from the resolution chart. It is important to view the chart from the proper distance because a difference of only a few inches can affect the apparent function of NVGs. The objective is to be able to see the grids well enough to determine whether the lines are horizontal or vertical. The grids may not be perfectly clear, but the direction of the lines should be readily apparent. Start by using the coarser grids, not trying to focus on the fine grids until after the diopter adjustment has been made.

Objective Focus. With one eye closed or one tube covered, turn the objective lens (outer ring) of the opposite tube while looking at one of the coarser grids. Attempt to bring the lines into sharp focus.

Diopter Focus. Next, turn the diopter focus adjustment (inner ring) counterclockwise until the image is blurred. Pause for one to two seconds, then turn the diopter adjustment clockwise until the image just becomes quite sharp – then stop. If, in an attempt to find the point of sharp focus the diopter ring is rotated too far, the procedure should be repeated beginning with the initial counterclockwise rotation.

CAUTION

Do not leave the diopter adjustment beyond the point at which the image becomes sharply focused, even though the image remains clear.

Performed correctly, this procedure focuses the image on the retina of the eye without accommodative effort by the eye muscles. Rotating the diopter ring beyond this point forces the eye muscles to actively work to keep the image focused. Over time, the eye muscles will become fatigued and unable to maintain focus. This results in a gradual loss of visual acuity and depth perception and often causes severe eyestrain and/or headache.

Note: The diopter adjustment is the adjustment most misunderstood by aircrew and one that can seriously degrade visual acuity if not performed correctly. It is **essential** to understand what the diopter adjustment accomplishes and how to properly perform the procedure.

Readjustment of Objective Focus. Once the diopter has been adjusted, fine tune the focus by readjusting with the objective ring to bring into focus as many of the grids as possible. At first it may take several attempts going back and forth between the diopter adjustment and objective adjustment to obtain the best focus. However, once one is comfortable with the procedure, focusing can be accomplished accurately and consistently with ease.

Focus of the Opposite Monocular. After focus of the first monocular has been accomplished, the same procedures are employed to focus and evaluate the remaining monocular. Do not be concerned if one side is slightly better than the other. Slight differences in the performance of individual intensification tubes are common.

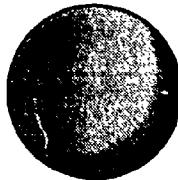
Assessment of Function

Evaluate Visual Acuity. Visual acuity obtained with both eyes should always be at least as good as the vision of the best side. If this is not the case, the goggles should be returned and another pair obtained. Further, it is recommended that the minimum acceptable visual acuity be 20/40.

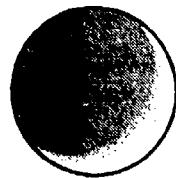
There is a solution on the back of the resolution chart that can be used to determine visual acuity based on the number of squares resolved. Remember, "resolved" means being able to determine if the lines in a square are horizontal or vertical. For example, when using the USAF high contrast NVG resolution chart, if eight of nine squares are resolved, the visual acuity is 20/40.

Note: As goggle performance improves, charts with higher resolution may be required and the solution may be different. If so, a key should be provided, either separately or printed on the back of the chart, to indicate the visual acuity associated with the number of squares resolved.

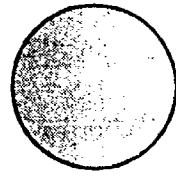
Evaluate Image. A number of image peculiarities and defects exist. The most common types are the following:



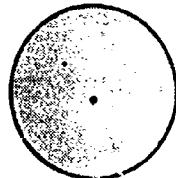
Shading. Appears as a shaded or indistinct area along the edge of the image. Attempt to eliminate it by moving the goggle toward the shading. If this is unsuccessful, do not use the goggle.



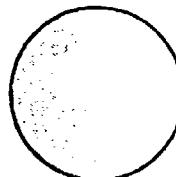
Edge Glow. Appearing as a bright area along the outer edge of the image, edge glow is most often the result of a bright light source. If noted, turn away from any bright lights or hold one hand over the objective lens. If the edge glow persists, it is an indication of damage to the intensification tube and the goggle should not be used.



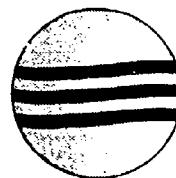
Bright Spots. Constant or flickering bright spots may appear anywhere in the image. Hold one hand in front of the objective lens. If bright spots are still present and they degrade the image and/or are distracting, do not use the NVG.



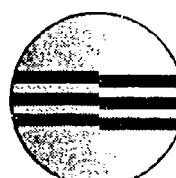
Dark Spots. Dark or black spots in the image. If large, numerous or located near the center of the image, the goggle should not be used. Maintenance should be notified so that the NVG can be checked to see whether or not it meets the military specifications.



Honeycomb. A honeycomb-like pattern in the image which is most often seen in high light-level conditions. If it is obvious or distracting, the NVG should not be used.



Distortion. The most common types of distortion noted in the NVG image are "bending" distortion and "shear" distortion. "Bending" distortion results in the image having a wavy appearance, usually in the horizontal or vertical directions. "Shear" distortion results in a choppy appearance somewhere in the image. If distortion is present and it is deemed likely to interfere with normal operations, do not use the NVG.



Flicker. The NVG image from one or both tubes may flash or flicker. The effect may occur only at a particular illumination level. If flicker is noted, do not use the NVG.

Scintillation. A normal finding at low light levels. It is seen as a sparkling effect over the image and represents electronic noise created at the high gain levels which occur during low illumination conditions. In flight, it can be an indication of decreasing illumination caused by such things as worsening weather conditions or flight into shadows.

Note Adjustment Settings. Remove the goggle from the mount and note the diopter settings. It is important to confirm that these settings have not been inadvertently changed before donning the NVG in the aircraft.

CAUTION

**Turn NVGs off prior to turning on the lights
and/or leaving the eye lane.**

Cockpit Procedures

Before donning NVGs in the aircraft, confirm that the IPD and diopter settings are the same as determined in the eye lane.

Because the device was focused at 20 feet in the eye lane, it will be necessary to refocus at infinity before flight. This can be accomplished by focusing on an object at least 75-feet distant, preferably one with well-developed vertical or horizontal features. It must be illuminated well enough to be easily seen with NVGs but not so brightly lit that the image blooms or washes out. Avoid focusing on incompatible lights because the halo effect they create makes it difficult to discern when the image is in precise focus. If the aircraft is equipped with a head-up display (HUD), the HUD symbology can be used since it is collimated to infinity. If there is nothing else available, a bright star or distant light can be used as a last resort.

Remember, refocus using the objective (front) ring **ONLY**. The diopter adjustment should never need to be changed from the setting determined in the test lane.

Practice donning and emergency removal of the goggles in the aircraft several times before flight.

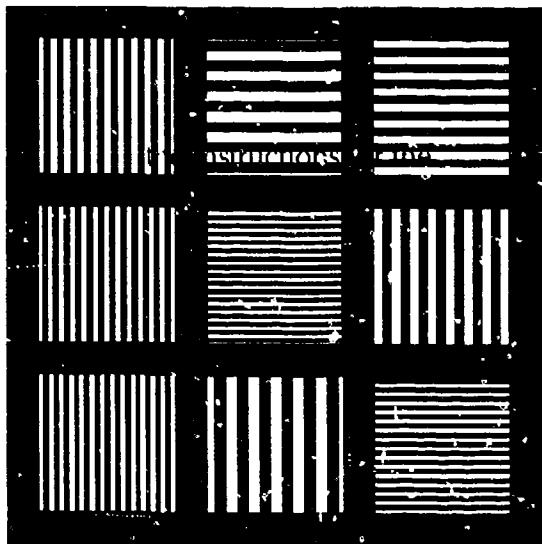
As the helmet settles or rotates during flight, it may be necessary to make minor adjustments in elevation and/or tilt. However, once adjusted correctly, the diopter should **never** need to be reset in flight.

SUPPORT ISSUES

Resolution Chart. The high resolution chart (Fig. 10) designed by the Armstrong Laboratory's Visual Display Systems Branch at Wright-Patterson AFB, OH, is recommended for use. It can be acquired from VisTech Consultants in Dayton, OH (phone 513-454-1399).

Eye Lane and Illumination Source. It is imperative that the instructions for the eye lane and illumination source be followed carefully. This will ensure proper NVG focus and evaluation. Specific instructions can be obtained from the Aircrew Training Research Division, Armstrong Laboratory in Mesa, AZ (DSN 474-6561, COMM 602-988-6561).

Preflight and Adjustment Quick References. An abbreviated set of preflight and adjustment instructions is attached (Appendices A and B). Place them in a conspicuous location, in or near the NVG eye lane.



*Figure 10
USAF High Contrast NVG Resolution Chart*

Appendix A

**ANVIS INSPECTION AND
INITIAL ADJUSTMENT PROCEDURES**

- 1. INSPECT HELMET**
- 2. INSPECT MOUNT ASSEMBLY**
- 3. INSPECT BATTERY PACK AND POWER CABLE**
- 4. LOAD BATTERIES**
- 5. ATTACH BATTERY PACK TO HELMET**
- 6. INSPECT BINOCULAR ASSEMBLY**
- 7. CLEAN LENSES**
- 8. SET DIOPTER TO ZERO**
- 9. SET EYE RELIEF FULL FORWARD AWAY FROM EYES**
- 10. CENTER TILT**
- 11. SET IPD**
- 12. SET VERTICAL AT CENTER OR KNOWN PERSONAL POSITION**
- 13. DON HELMET, THEN ATTACH NVGs**
- 14. PRACTICE MOUNTING AND REMOVING THE NVGs**

Appendix B

ANVIS ADJUSTMENT AND ASSESSMENT PROCEDURES

1. ROOM LIGHTS - Off
2. GOGGLE POWER - On
3. ALIGNMENT PROCEDURES
 - Adjust vertical
 - Adjust tilt
 - Adjust eye relief
 - Assess IPD
 - Evaluate image
4. FOCUSING PROCEDURES - One eye at a time
 - Focus objective (outer) ring
 - Focus diopter (inner) ring
 - counterclockwise until blurred
 - clockwise until just quite sharp
 - Fine tune objective focus
5. ASSESSMENT OF FUNCTION
 - Evaluate visual acuity with both eyes open
 - Note diopter settings
6. COCKPIT PROCEDURES
 - Confirm diopter settings
 - Refocus to infinity
 - Practice emergency removal